N92-15855

1991

NASA/ASEE Summer Faculty Fellowship Program

Marshall Space Flight Center
The University of Alabama

Development and Application of Virtual Reality for Man/Systems Integration

Prepared By:	Marcus Brown, Ph.D.
Academic Rank:	Assistant Professor
Institution:	The University of Alabama Computer Science Department
NASA/MSFC:	
Office:	Science & Engineering
Division:	Missions Operations Lab
Branch:	Man/Systems Integration
MSFC Colleague:	Joe Hale
Contract No.:	NGT-01-008-021 The University of Alabama

Since the first applications of the earliest computers, one question which has always been present is the question of presenting the information in the computer to the human who uses the computer. Through different computers and applications, different answers to this problem have been presented. Many of these answers have been appropriate for a small class of highly trained individuals, but even when users have learned the computer's output language, the patterns and relationships in the data have not always been evident. This is particularly true when attempting to present data about various physical models. The computer has been used to model automobiles, rockets, buildings, road systems, and many other physical models. While some applications of these models have been designed to produce textual or numerical results for special requirements, results in this form often fail to convey a complete picture of the model. This results in the user having some misconceptions which are only rectified later, perhaps when a physical model is built.

An alternative approach to textual and/or numerical results from these computer models has been to present a graphical image of the model. The user is able to perceive the model in a form similar to what she might perceive in an actual physical model. This has often lead to a better appreciation of the model, and perhaps to corrections when the model has needed adjustments.

While the graphical presentation of computer models signified a quantum leap over presentations limited to text and numbers, it still has the problem of presenting an interface barrier between the human user and the computer model. The user must learn a command language in order to orient herself in the model. For example, to move left from the current viewpoint of the model, she might be required to type 'LEFT' at a keyboard. This command is fairly intuitive, but if the viewpoint moves far enough that there are no visual cues overlapping with the first view, the user does not know if the viewpoint has moved inches, feet or miles to the left, or perhaps remained in the same position, but rotated to the left. Until the user becomes quite familiar with the interface language of the computer model presentation, she will be prone to loosing her bearings frequently. Even a highly skilled user will occasionally get lost in the model.

A new approach to presenting type type of information is to directly interpret the user's body motions as the input language for determining what view to present. When the user's head turns 45 degrees to the left, the viewpoint should be rotated 45 degrees to the left. Since the head moves through several intermediate angles between the original view and the final one, several intermediate views should be presented, providing the user with a sense of continuity between the original view and the final one.

Since the primary way a human physically interacts with her environment is by using her hands to manipulate objects, this type of interface should monitor the movements of the users hands, and alter objects in the virtual model in a way consistent with the way an actual object would move when manipulated using the same hand movements.

Since this approach to the computer-human interface closely models the same type of interface that humans have with the physical world they have lived in since long before computers were invented, this type of interface is often called **virtual reality**, and the model is referred to as a **virtual world.**

This summer's fellowship task was to set up a virtual reality system at Marshall Space Flight Center, and begin applying it to some of the questions which concern scientists and engineers involved in space flight.

Setting up the virtual reality system was fairly straightforward. Most of the hardware and basic software was ready at the beginning of the summer.

The input devices are unusual, and deserve explanation. First, the position of various body parts must be sensed, and that information fed into the computer model. While various devices might be used to sense this information, this system uses a magnetic sensing device. A magnetic source is put in a fixed location, and a sensor is put on the part of the body where information is desired, such as on the head and right hand. This allows the user's movements to be communicated to the computer without unduly interfering with the user's freedom of movement. This magnetic sensor gives information about the position and orientation, so when the user turns her head, the computer is able to compensate for that movement, even though the head may not have moved to a different position.

Sensing the movement of the hand presents an additional problem. Not only is it necessary to know the position and orientation of the hand, but for realistic interaction, the computer system must also have information about the flexion of the fingers and thumb. This is accomplished by wearing a glove which uses fiberoptics to sense joint flexion. Two joints on each finger are measured. This allows the user a small repertoire of gestures, such as 'Point' and 'Grab', which allow her to interact with the objects in the virtual world of the computer model.

There are two parts to building a virtual world. First, a 3D modelling package is used to define the objects in the virtual world. These objects may include walls, floors, tables, etc. It is usually appropriate to define a set of constraints for the objects. It may be desirable to fix the position of a wall so that the user cannot move it. Other objects may be moveable, but only through a limited range.

After the objects are built, a certain amount of programming must be done to determine the properties of the objects, and how they will interact with the user. Most objects, by default, will allow other objects to intersect and completely pass through them. This property is sometimes desirable, but in many cases it is more appropriate to force objects to move away from each other rather than intersect. This type of interaction must be programmed into the system for each pair of objects.

Once the virtual reality system was working, the next task was to apply the tool to a specific problem facing NASA. The first problem approached dealt with the placement of the Crystal Growth Furnace in a rack in the Space Station. The CGF is large enough that it fills the racks using in the space station. This means that there is not enough room to load the 24-inch long samples which must be inserted into the top of the CGF. The solution to this problem is to tilt the CGF forward and allow more room to work. Three different pivot points have been proposed, but each has concerns about the amount of clearance required, particularly about whether the human operator would have the room necessary to manipulate the different samples and pieces necessary to the job.

A virtual world has been created which holds a section of the space station, several racks, and a model of the CGF in a rack. This virtual world will be used to check for adequate room to work, using each of the three proposed pivot points. The alternative to solving the problem this way is to build a physical mockup at a cost of $30,000. Using a virtual world has a large startup cost for the necessary computers, but the cost of the model and the trials is almost negligible.

It is hoped that further applications of virtual reality can realize additional cost savings, and allow a more intuitive interface between the human user and the computer model.